Summary Report of The First International Competition on Computational Models of Argumentation

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We review the First International Competition on Computational Models of Argumentation (ICMMA'15). The competition evaluated submitted solvers performance on four different computational tasks related to solving abstract argumentation frameworks. Each task evaluated solvers in ways that pushed the edge of existing performance by introducing new challenges. Despite being the first competition in this area, the high number of competitors entered, and differences in results, suggest that the competition will help shape the landscape of ongoing developments in argumentation theory solvers.

Introduction

Computational models of argumentation are an active research discipline within Artificial Intelligence that has grown since the beginning of the 1990s (Dung 1995). While still a young field when compared to areas such as SAT solving and Logic Programming, the argumentation community is very active, with a conference series (COMMA, which began in 2006) and a variety of workshops and special issues of journals. Argumentation has also worked its way into a variety of applications. For example, Williams et al. (2015) described how argumentation techniques are used for recommending cancer treatments, while Toniolo et al. (2015) detail how argumentation-based techniques can support critical thinking and collaborative scientific inquiry or intelligence analysis.

Many of the problems that argumentation deals with are computationally difficult, and applications utilising argumentation therefore require efficient solvers. To encourage this line of research, we organised the First International Competition on Computational Models of Argumentation (ICCMA), with the intention of assessing and promoting state of the art solvers for abstract argumentation problems, and to identify families of challenging benchmarks for such solvers.

The objective of ICCMA'15 is to allow researchers to compare the performance of different solvers systematically on common benchmarks and rules. Moreover, as witnessed by competitions in other AI disciplines such as planning and SAT solving, we see ICCMA as a new pillar of the community which provides information and insights on the current state of the art, and highlights future challenges and developments.

This article summarises the first ICCMA held in 2015 (ICCMA'15). In this competition, solvers were invited to address standard decision and enumeration problems of abstract argumentation frameworks (Dunne and Wooldridge 2009). Solvers' performance is evaluated based on their time taken to provide a correct solution for a problem; incorrect results were discarded. More information about the competition, including complete results and benchmarks, can be found on the ICCMA website.[1]

Tracks

In abstract argumentation (Dung 1995), a directed graph (A, R) is used as knowledge representation formalism, where the set of nodes A are identified with the arguments under consideration and R represents a conflict-relation between arguments, i. e., aRb for $a, b \in A$ if a is a counterargument for b. The framework is abstract because the content of the arguments is left unspecified. They could, for example, consist of a chain of logical deductions from logic programming with defeasible rules (Simari 1992); a proof for a theorem in classical logic (Besnard and Hunter 2007); or an informal presumptive reason in favour of some conclusion (Walton, Reed, and Macagno 2008). The notion of conflict then depends on the chosen formalisation. Irrespective of the precise formalisation used, one can identify a subset of arguments that can be collectively accepted given inter-argument conflicts. Such a subset is referred to as an *extension*, and (Dung 1995) defined four commonly used argumentation semantics — namely the complete (CO), preferred (PR), grounded (GR), and stable (ST) semantics — each of which define an extension differently. More precisely, a complete extension is a set of arguments which do not attack each other, and in which arguments defend each other;[2] a preferred extension is a maximal (w.r.t. set inclusion) complete extension; the grounded extension is the minimal (w.r.t. set inclusion) complete extension; and a stable extension is a complete extension such that each argument not in the extension is attacked by at least one argument within the extension.

The competition was organized around four computational tasks of abstract argumentation:

1. Given an abstract argumentation framework, determine some extension (SE)
2. Given an abstract argumentation framework, determine all extensions (EE)
3. Given an abstract argumentation framework and some argument, decide whether the given argument is contained in some extension (DC)
4. Given an abstract argumentation framework and some argument, decide whether the given argument is contained in all extensions (DS)

Combining these four different tasks with the four semantics discussed above yields a total of 16 tracks that constituted ICCMA'15. Each submitted solver was free to support any number of these tracks.

Participants

The competition received 18 solvers from research groups in Austria, China, Cyprus, Finland, France, Germany, Italy, Romania, and UK, of which eight were submitted to all tracks. The solvers used a variety of approaches and programming languages to solve the competition tasks. In particular, five solvers were based on transformations of argumentation problems to SAT, three on transformations to ASP, two on CSP, and eight were built on tailor-made algorithms. Seven solvers were implemented in C/C++, four in Java, two used shell-scripts for translations to other formalisms, and the remaining solvers were implemented in Haskell, Lisp, Prolog, Python, and Go.

All participants were required to submit the source code of their solver, which was made freely available after the competition, to foster independent evaluation and exploitation in research or real-world scenarios, and to hopefully allow for further refinements.

Submitted solvers were required to support the *probo* (Cerutti et al. 2014) command line interface, which was specifically designed for running and comparing solvers within ICCMA.

Performance Evaluation

Each solver was evaluated over N different argumentation graph instances within each track ($N = 192$ for SE and EE, and 576 for DC and DS). Instances were generated with the intention of being challenging — one group of instances was generated so as to contain a large grounded extension and few extensions in the other semantics. This group's graphs were large (1224 to 9473 arguments), and challenged solvers which scaled poorly (i.e., those which used combinatorial approaches for computing extensions). A second group of instances was smaller (141 to 400 arguments), but had a rich structure of stable, preferred, and complete extensions (up to 159 complete extensions for the largest graphs) and thus provided combinatorial challenges for solvers relying on simple search-based algorithms. A final group contained medium-sized graphs (185 to 996 arguments), and featured many strongly connected components with many extensions. This group was particularly challenging for solvers not able to decompose the graph into smaller components.

Each solver was given 10 minutes to solve an instance. For each correctly and timely solved instance the solver received one point, and a ranking for each track was obtained based on points scored on all its instances. Ties were broken by considering total runtime on all instances. Additionally, a global ranking of the solvers across all tracks was generated by computing the Borda count of all solvers in all tracks.

Results and Concluding Remarks

The obtained rankings for all 16 tracks can be found on the competition website.[3] The global ranking identified the following top three solvers:

1. CoQuiAAS
2. ArgSemSAT
3. LabSATSolver

Another solver, Cegartix, participated in only three tracks (SE-PR, EE-PR, DS-PR), but came top in all of these. It is interesting to note that these four solvers are based on SAT-solving techniques. Additionally, an Answer Set Programming based solver (ASPARTIX-D) came first in the four tracks related to the stable semantics; there is a strong relationship between these semantics and the answer set semantics which probably explains its strength in these tracks. Information on the solvers and their authors can also be found on the homepage of the competition.

Given the success of the competition, a second iteration will take place in 2017 with an extended number of tracks.

Notes

[1]http://argumentationcompetition.org/

[2]$S \subseteq A$ defends a if $\forall bRA$, $\exists c \in S$ s.t. cRb, that is, all attackers of a are counter-attacked by S.

[3]http://argumentationcompetition.org/2015/results.html

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Short Bios

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